SUBFREEZING CONDITIONS AFTER SEEDING CAN REDUCE SOUTHERN PINE SEED GERMINATION

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Generally, freezing in ice greatly reduced seed viability. Of seeds frozen in ice, a higher percentage of partially imbibed seeds germinated than fully imbibed seeds. Imbibed seeds held out of water at 0° F were not harmed as much as those frozen in ice.

A troublesome aspect of direct seeding southern pines is that the ratio of seedlings to seeds sown usually is low. Typically, about 25 percent of the seeds become established seedlings (*3*); the large losses result from predation, disease, and unfavorable weather. Seed injury from cold weather, which can affect seeds that are in small pools of water and others on the soil surface, has not previously been studied. This study evaluates the effects of a wide range of conditions under which seeds may be frozen and their effects on the germination of slash (*Pinus elliottii* Engelm.), loblolly (*P. taeda* L.), and longleaf (*P. palustris* Mill.) pine seeds.

Methods

Three lots of fresh seed of each species were used to evaluate the effects of five treatments on germination. The treatments were (1) a control, (2) soaking seeds in 34° F water for 3 days, (3) freezing partially imbibed and (4) fully imbibed seeds in ice at 0° F for 3 days, and (5) freezing imbibed seeds out of water at 0° F for 3 days. All fully imbibed seeds were soaked for 16 hours in 72° F water before freezing. Partially imbibed seeds were placed in 72° F water that was moved directly to a 0° F temperature, which allowed the seeds to absorb moisture until the water froze.

Three 100-seed replications were germinated under standard laboratory conditions of 72° F and a 16-hour photoperiod. All seeds were unstratified, and germination is expressed on a sound seed basis. Germination percents and Czabator's germination values (*2*), which express completeness and speed of germination, were used to evaluate responses to the treatments.

Results

Longleaf Pine

The longleaf seeds that were soaked 3 days in 34° F water and the fully imbibed seeds held out of water at 0° F averaged 96 and 94 percent germination, significantly higher than the control seeds which averaged only 90 percent germination (table 1). The two treatments in which seeds were frozen in ice had significantly lower germination than the control, and germination percents varied with treatments among the seed lots. The poorest germination of longleaf seeds occurred in lot 3

Table 1.—*Germination percents of longleaf, loblolly, and slash pine seeds following exposure to cold-weather conditions for 3 days*

Treatments	Longleaf pine				Loblolly pine				Slash pine			
	Lot 1	Lot 2	Lot 3	Avg.	Lot 1	Lot 2	Lot 3	Avg.	Lot 1	Lot 2	Lot 3	Avg.
	Percent											
Control (no soak)	88	93	90	90	91	95	88	91	95	97	99	97
Cold-water soak (3 days at 34° F)	95	98	94	96	96	95	87	93	96	97	98	97
Fully imbibed and frozen in ice	93	91	52	79	48	78	81	69	90	73	63	75
Partially imbibed and frozen in ice	73	89	88	83	89	92	92	91	88	92	96	92
Fully imbibed and held out of water at 0° F	92	96	95	94	90	92	83	88	95	92	63	83

Table 2.—*Germination values of longleaf, loblolly, and slash pine seeds following exposures to cold-weather conditions for 3 days*

Treatments	Longleaf pine				Loblolly pine				Slash pine			
	Lot 1	Lot 2	Lot 3	Avg.	Lot 1	Lot 2	Lot 3	Avg.	Lot 1	Lot 2	Lot 3	Avg.
	— — — — — — — — — — — — *Values* — — — — — — — — — — — —											
Control (no soak)	35.4	30.4	21.6	29.1	14.8	18.4	12.1	15.1	28.1	40.9	31.7	33.6
Cold-water soak (3 days at 34° F) .	45.5	47.8	29.5	40.9	22.4	19.8	11.7	18.0	39.7	43.1	39.5	40.8
Fully imbibed and frozen in ice . .	43.2	35.8	8.6	29.2	4.7	11.3	11.4	9.1	25.5	17.5	8.9	17.3
Partially imbibed and frozen in ice .	24.1	33.8	23.0	27.0	15.3	13.8	13.9	14.3	24.4	39.8	31.1	31.8
Fully imbibed and held out of water at 0° F	42.2	44.4	28.4	38.3	14.9	18.4	12.9	15.4	33.8	38.8	12.2	28.3

of the seeds that were fully imbibed and frozen in ice; germination of the partially imbibed seeds was poorest in lot 1.

The cold water soak treatment and, surprisingly, the 0° F exposure of imbibed seeds significantly increased . germination values (table 2). The other treatments had values similar to the control.

Loblolly Pine

An average of 69 percent of the fully imbibed, frozen-in-ice loblolly pine seeds germinated (table 1). This was the only treatment that significantly reduced germination of loblolly pine seeds. The 48-percent germination of the lot 1 seeds that were frozen in ice was caused by an interaction of treatment with seed lot. Average germination ranged from 88 to 93 percent for the other four treatments (table 1), and viability of lot 1 when exposed to these treatments remained high.

The germination values followed trends similar to those for percentages. Imbibing seeds fully and freezing them in ice gave low values, primarily because of the poor germination of lot 1 seeds (table 2).

Slash Pine

The response of slash seeds to treatment was more erratic than the responses of longleaf and loblolly seeds. Average germination of the control and of the seeds soaked in cold water for 3 days were significantly higher than the average germination of seeds that were fully imbibed and frozen in ice and higher than the germination of seeds that were fully imbibed and held out of water at 0° F (table 1). The interaction of seed lots and treatments was again significant. In lot 3, 63 percent of both the fully imbibed, frozen-in-ice seeds and the seeds held out of water at 0° F, germinated; 90 and 95 percent germinated for the same treatments in lot 1.

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The control and the cold water soak at 34° F had significantly higher germination values than the other three treatments (table 2). The fully imbibed frozen seeds again had the lowest values. Little difference existed between germination values for frozen, partially imbibed seeds and those for seeds imbibed and held at 0° F.

Discussion

The cold water soaks tended to speed germination and raised the germination percent for two of the three species. The effects of 0° F temperatures varied among species and seed lot. Freezing fully imbibed seeds out of water at 0° F was the least harmful of the freezing conditions to the seeds of all species, and longleaf seeds given this treatment germinated better and more quickly than control seeds. Freezing fully imbibed seeds in ice was the most harmful treatment to seeds of all species.

When seeds are frozen, their megagametophyte and embryo expand. The strong seedcoats of loblolly and slash pines may have injured these internal portions when fully imbibed seeds of these species were frozen. Longleaf has a seedcoat that expands and ruptures easily, and freezing may have stimulated longleaf's germination by helping to rupture the seedcoat.[1] When seeds are frozen in ice, their seedcoats cannot expand. Thus, partially imbibed seeds of loblolly and slash may be damaged less by freezing than longleaf seeds because more space for expansion exists within their coats.

Although freezing fully imbibed seeds out of water may not be detrimental to germination, freezing any seeds should be avoided if possible. The lots selected for this study had high vigor and viability. Less vigorous lots are more likely to be damaged. Of the three species, longleaf is least susceptible to damage, but one of three longleaf seed lots suffered severe injury. Generally, seeding should be done after the likelihood of freezing weather is past. Longleaf, which is usually fall sown, should be seeded so that germination occurs before severe weather begins, or seeding can be delayed until spring when clipping by animals will be less frequent (*1*).

[1]Barnett, J.P. [1976] Delayed germination of southern pine seeds related to seedcoat constraint. Canadian J. For. Res. (in press).

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